
Source: C. Benton

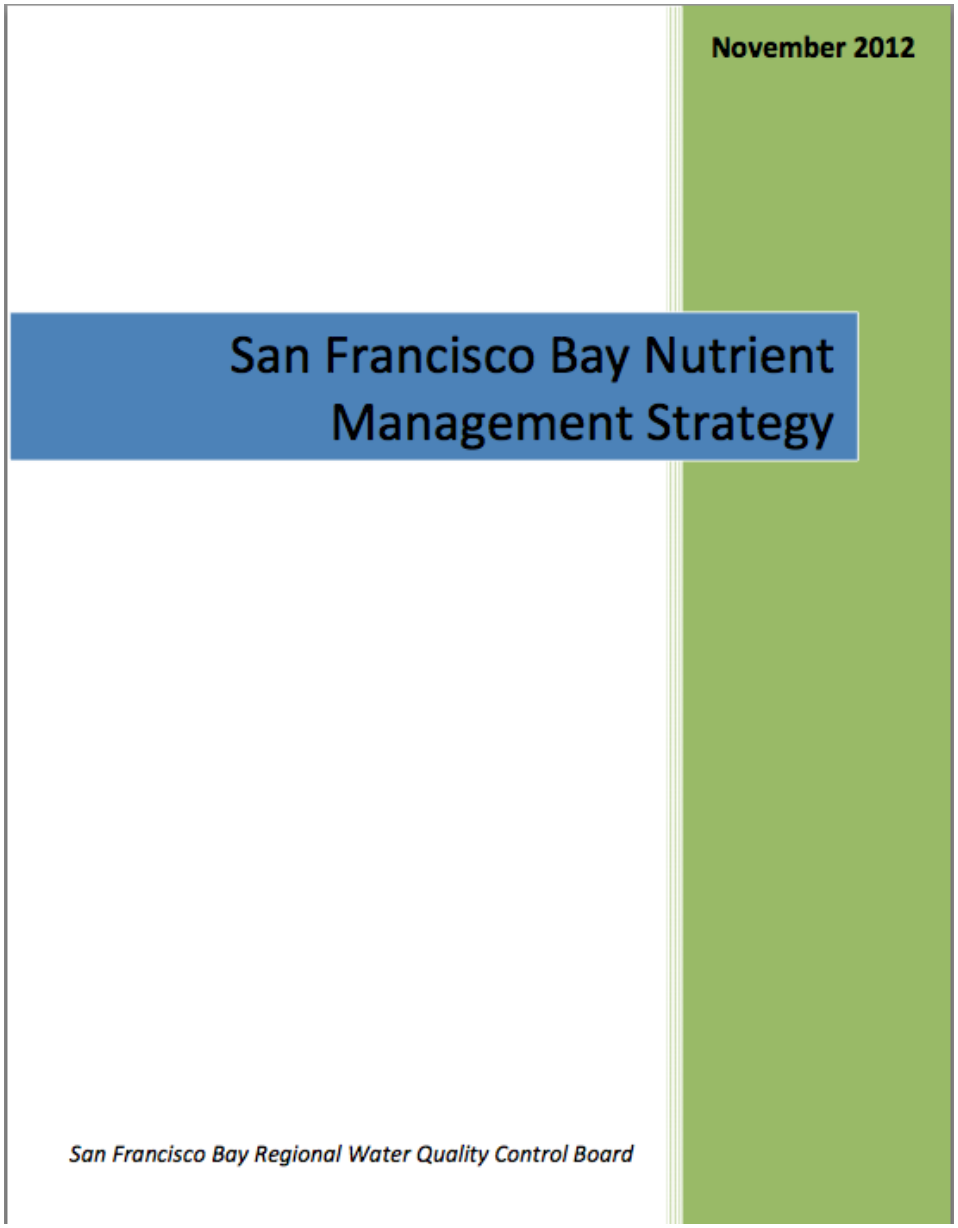
Nutrient Program Update

1. Nutrient Strategy Update

2. Assessment Framework

3. Updates
   - Conceptual Model
   - Loading Study
   - Suisun Synthesis
   - Funded projects in 2013
   - Other priorities

Status of Nutrient Strategy



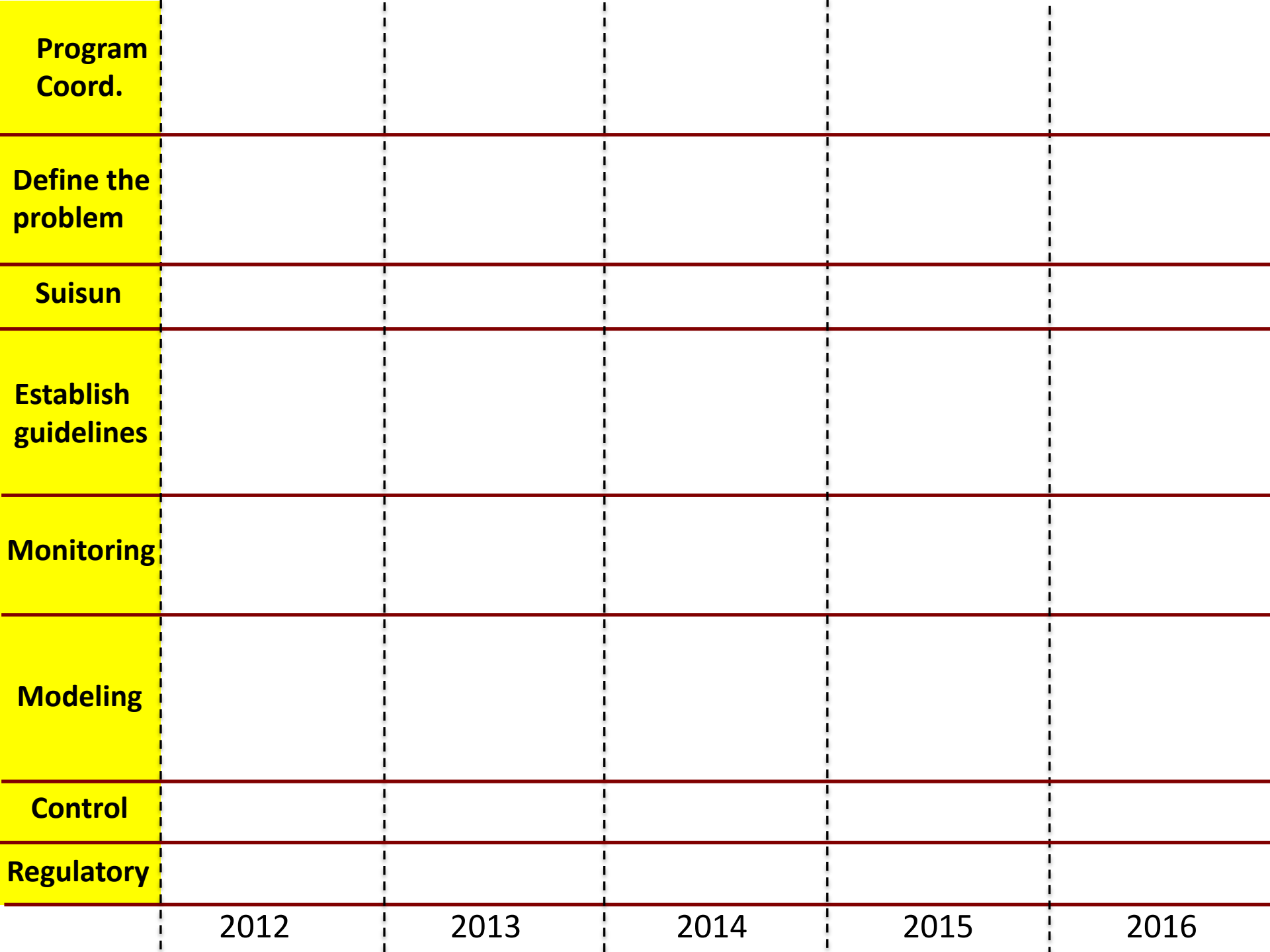
- Initial strategy: March 2012
- Comments and discussion
  - SAG: March 2012
  - Comments: May 2012
- Revised strategy out
  - November 2012

Major changes to Nutrient Strategy

- Two new Work Elements:
  - *Program coordination*
    - Establishing governance/decision-making structure
    - Peer review
    - Fundraising plan
  - *Suisun Bay*
    - Identifies tasks specific to Suisun Bay
      - On-going field and experimental studies
      - NH4, primary production and copepods
      - N:P, NH4:NO3

Major changes to Nutrient Strategy

- Synthesis tasks…existing data
- Special studies
- Revised assessment framework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Suisun
Establish guidelines
Monitoring
Modeling
Control
Regulatory
2012
2013
2014
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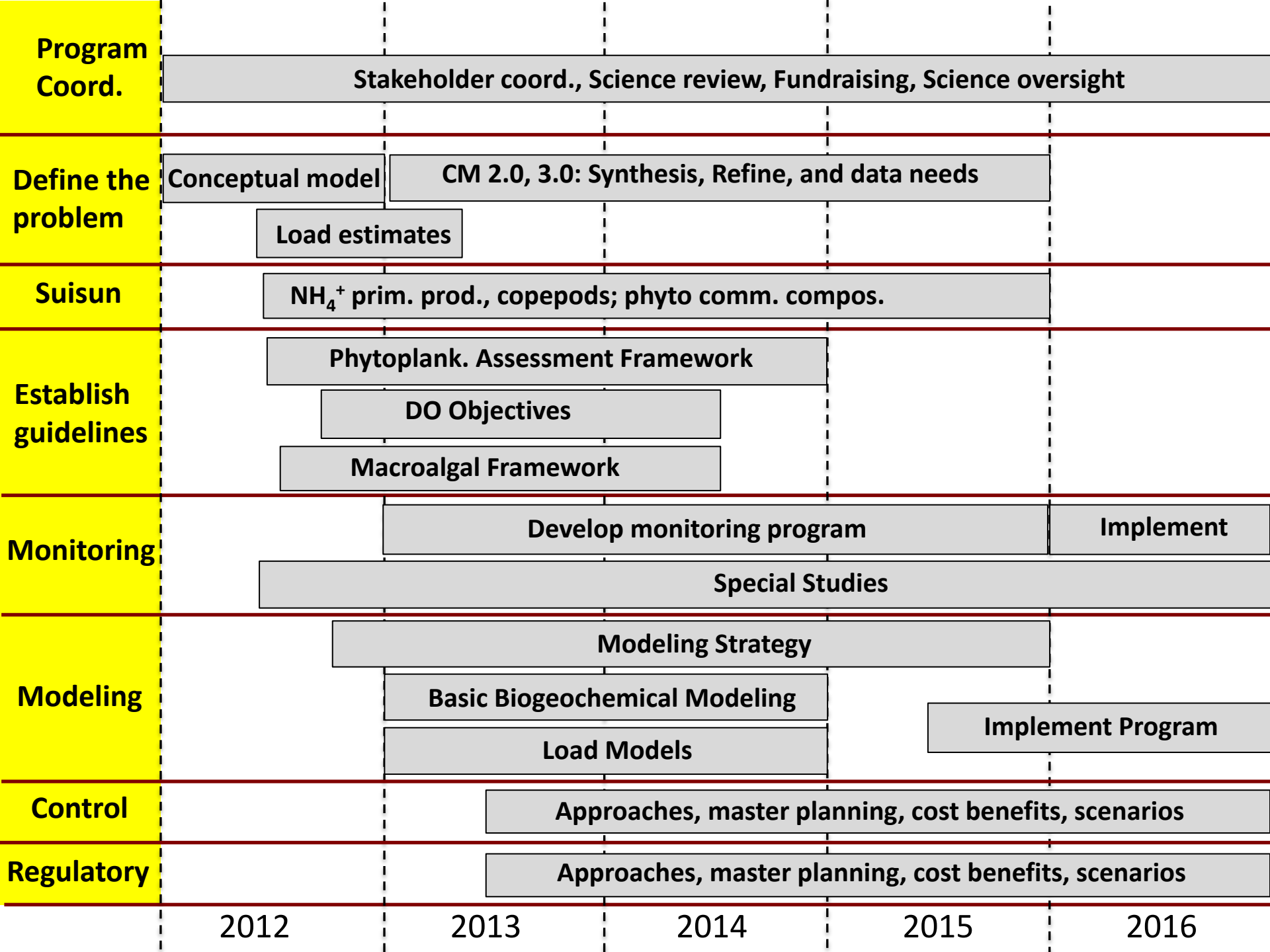
2016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Phytoplank. Assessment Framework
DO Objectives
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Monitoring
Develop monitoring program
Implement
Special Studies
Modeling
Modeling Strategy
Basic Biogeochemical Modeling
Load Models
Implement Program
Control
Approaches, master planning, cost benefits, scenarios
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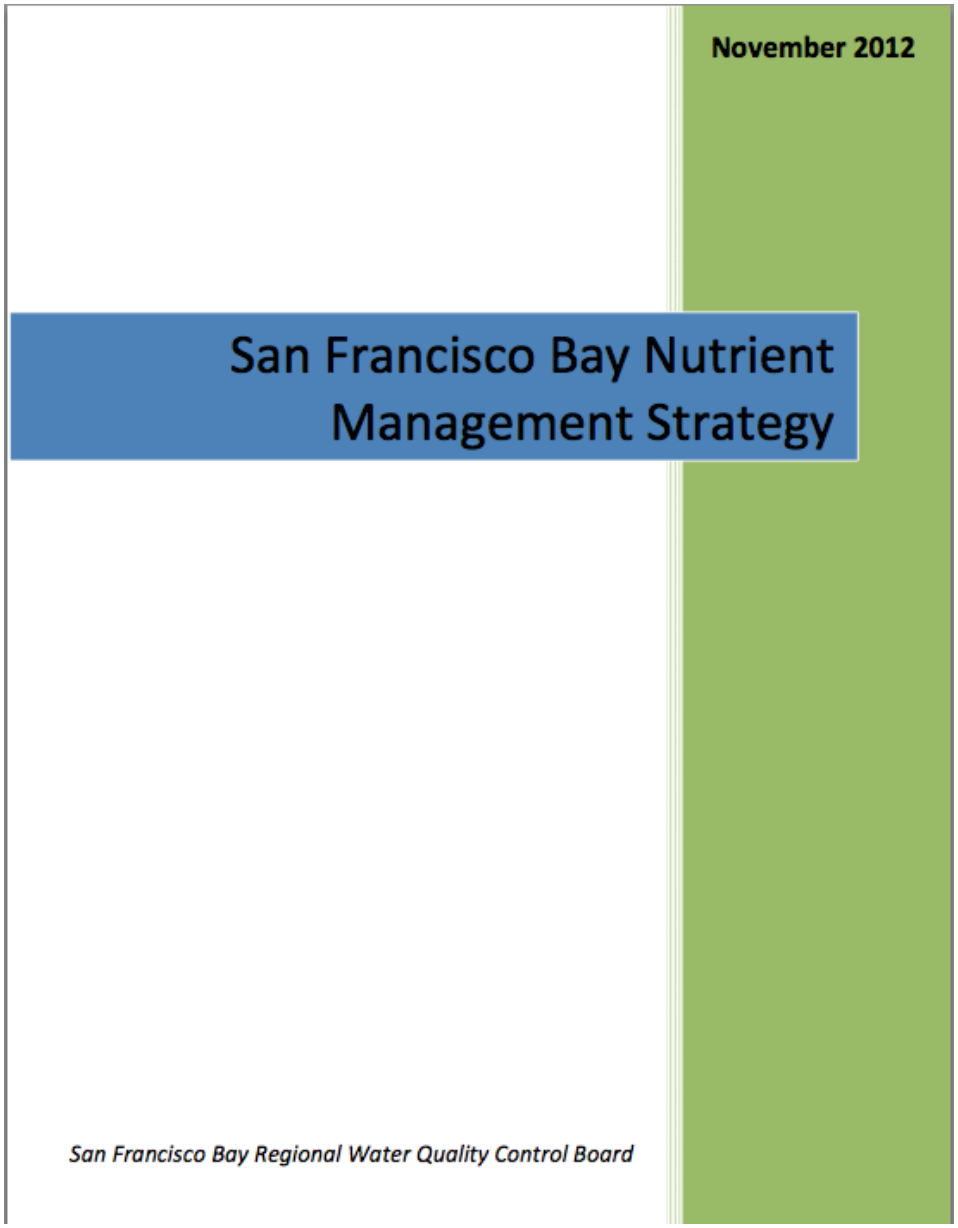

NEXT STEPS…

- Governance/decision-making structure
- Further prioritization…regulatory decisions and science needs
- Fine-tuning
- Other?


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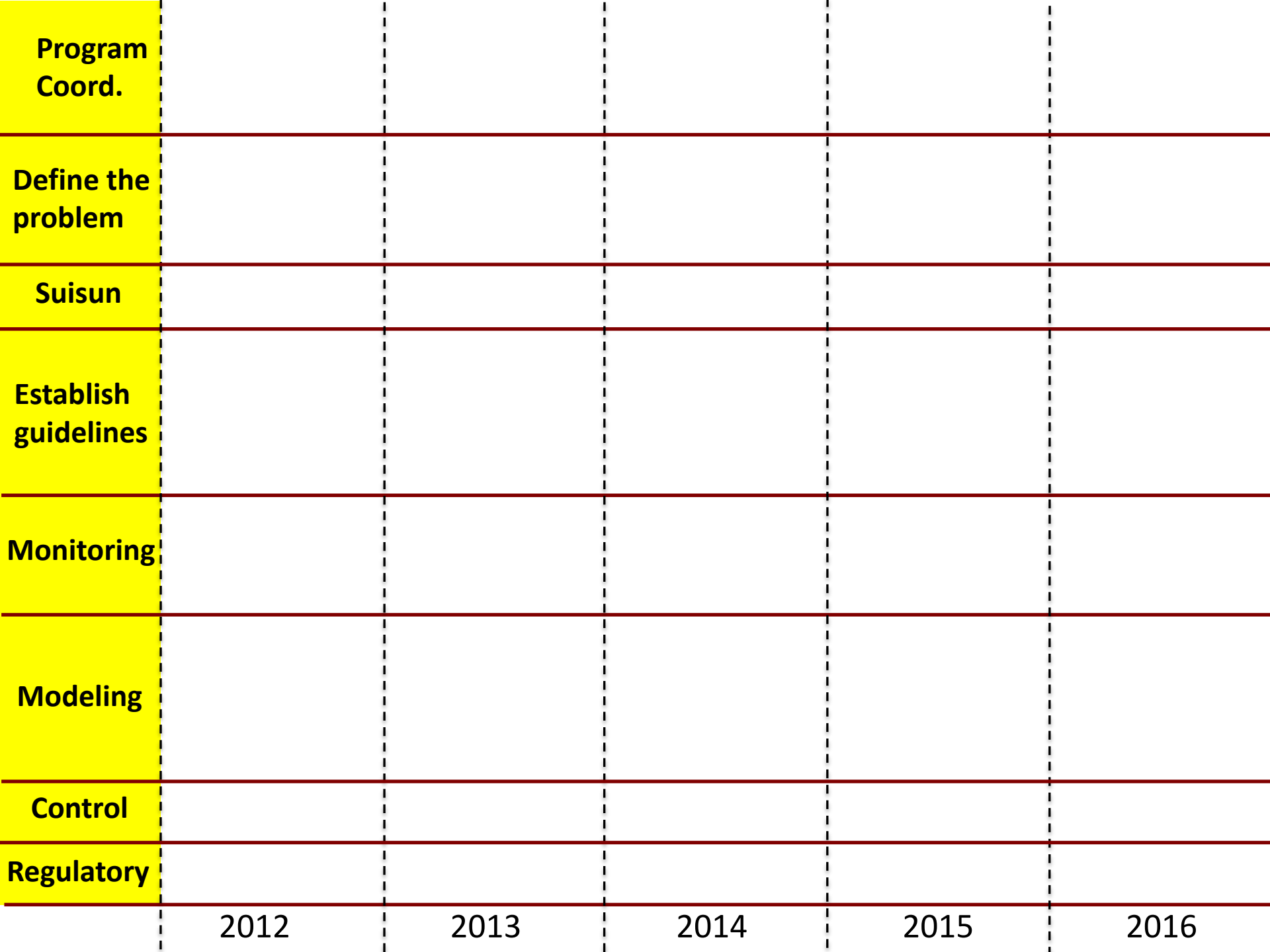
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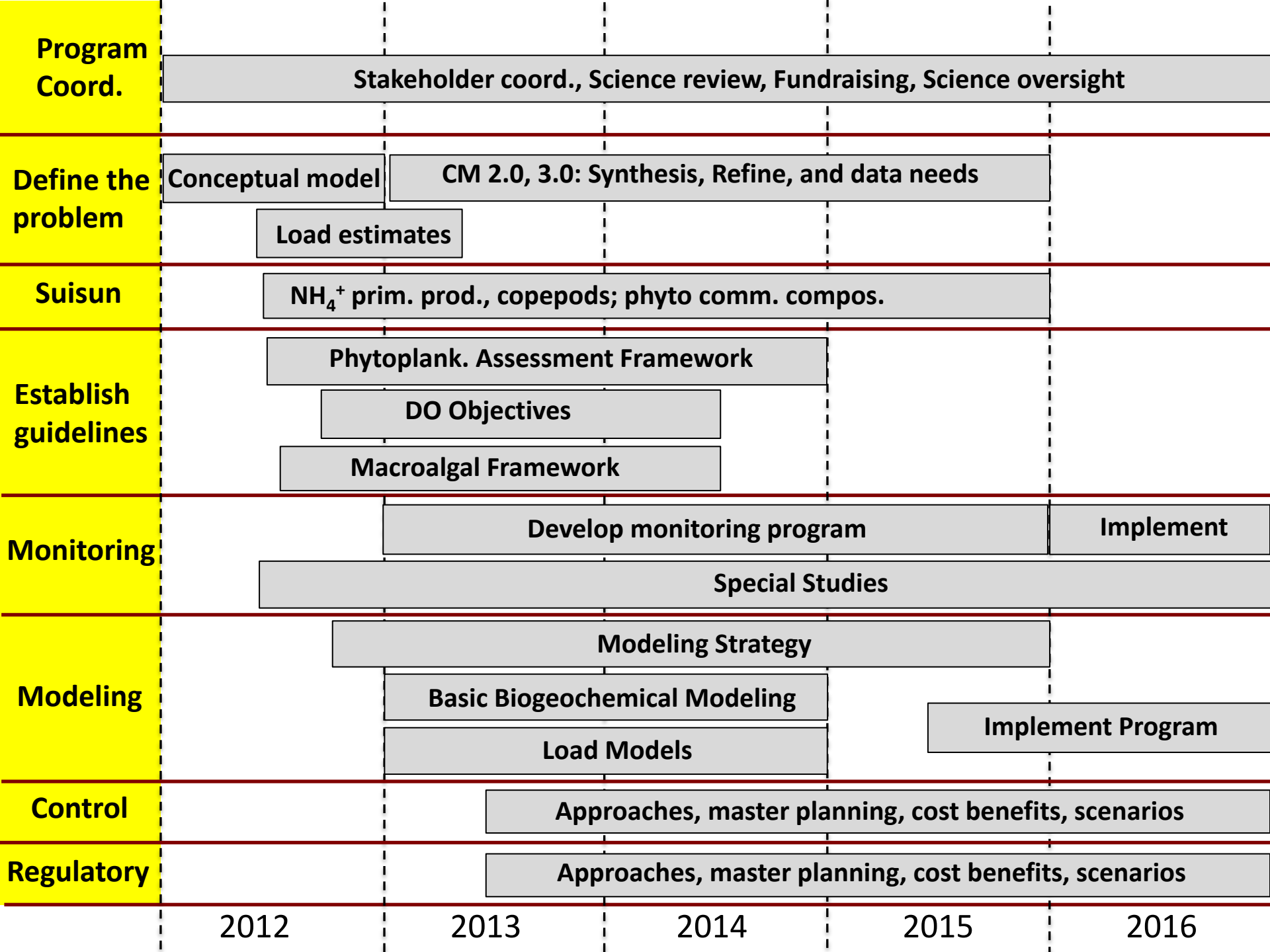
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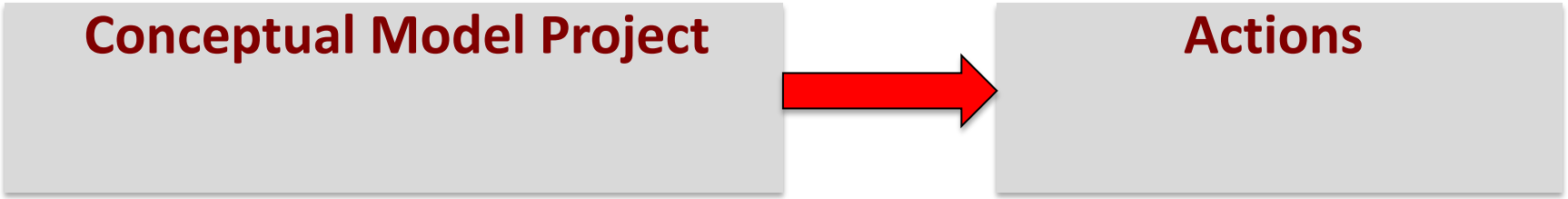
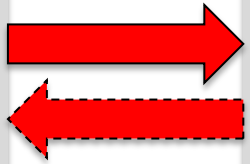

Conceptual Model Project
Actions

Conceptual Model Project

Problem Statement

What would a problem look like in SFB?



Actions

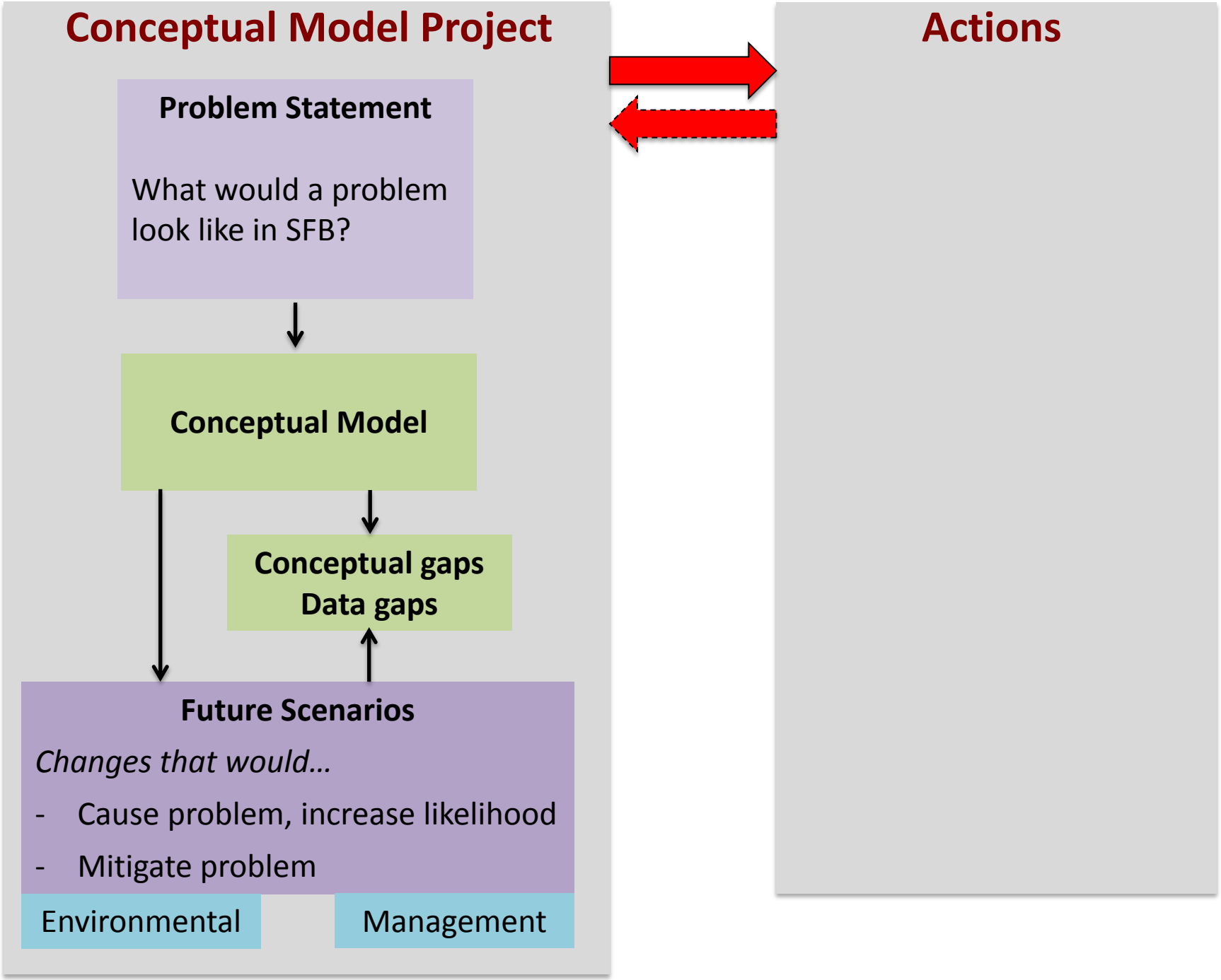
Future Scenarios

Changes that would…

- Cause problem, increase likelihood
- Mitigate problem

Environmental

Management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Data gaps
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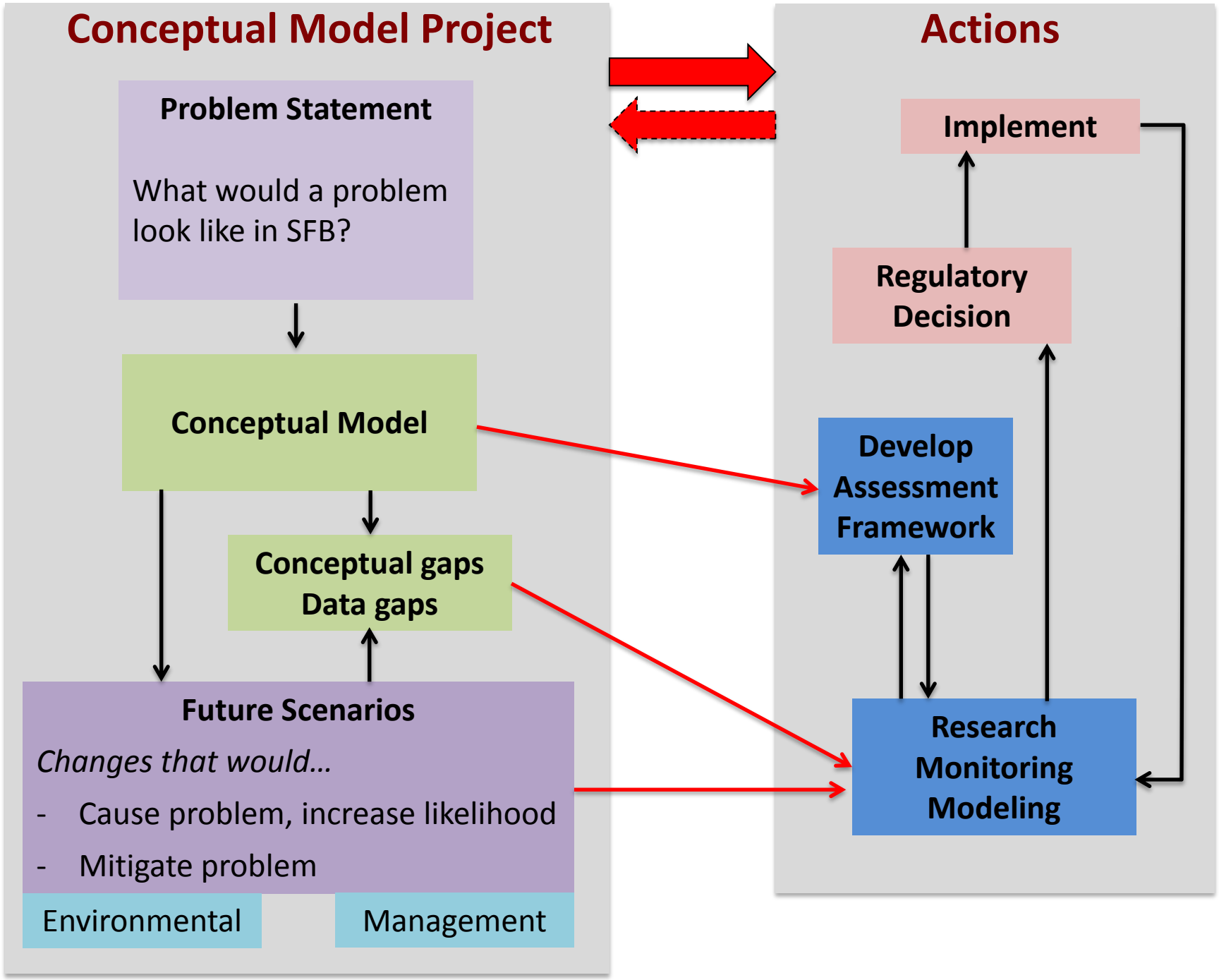
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Environmental
Management
Implement
Regulatory Decision
Develop Assessment Framework
Research Monitoring Modeling

Management questions

1. Is there a nutrient problem or are there signs of a problem?
   - Currently, or trending towards, adversely affecting beneficial uses?
   - Guidelines for identifying a nutrient-related problem?

2. What is the relative contribution of each loading pathway?

3. What nutrient loads can the Bay assimilate without impairment of beneficial uses?

4. What is the likelihood that the Bay will be impaired by nutrient overenrichment/eutrophication in the future?

Goals of Report

- Develop a "problem statement" – what would a problem look like?

- Develop conceptual models: nutrients and ecosystem response in SFB
  - Identify areas of agreement in scientific community
  - Identify major conceptual gaps or data gaps to improve ability to identify current problems, and anticipate potential future problems

- Use conceptual models to identify relevant environmental change or management scenarios

Goals of Report

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Audience and anticipated use

- *Primary Audience:* Technical regulators/managers and stakeholders

- *Anticipated uses*…Provide an overarching framework within which to
  - Consider future scenarios and management options

  - Prioritize research to inform management decisions

  - Inform structure and goals of monitoring and numerical modeling

Approach

- Collaborative approach with team of regional experts
  - J Cloern — USGS
  - M Connor — EBDA
  - D Dugdale — SFSU-RTC
  - T Hollibaugh — U Georgia
  - W Kimmerer — SFSU-RTC
  - L Lucas — USGS
  - R Kudela — UC Sant Cruz
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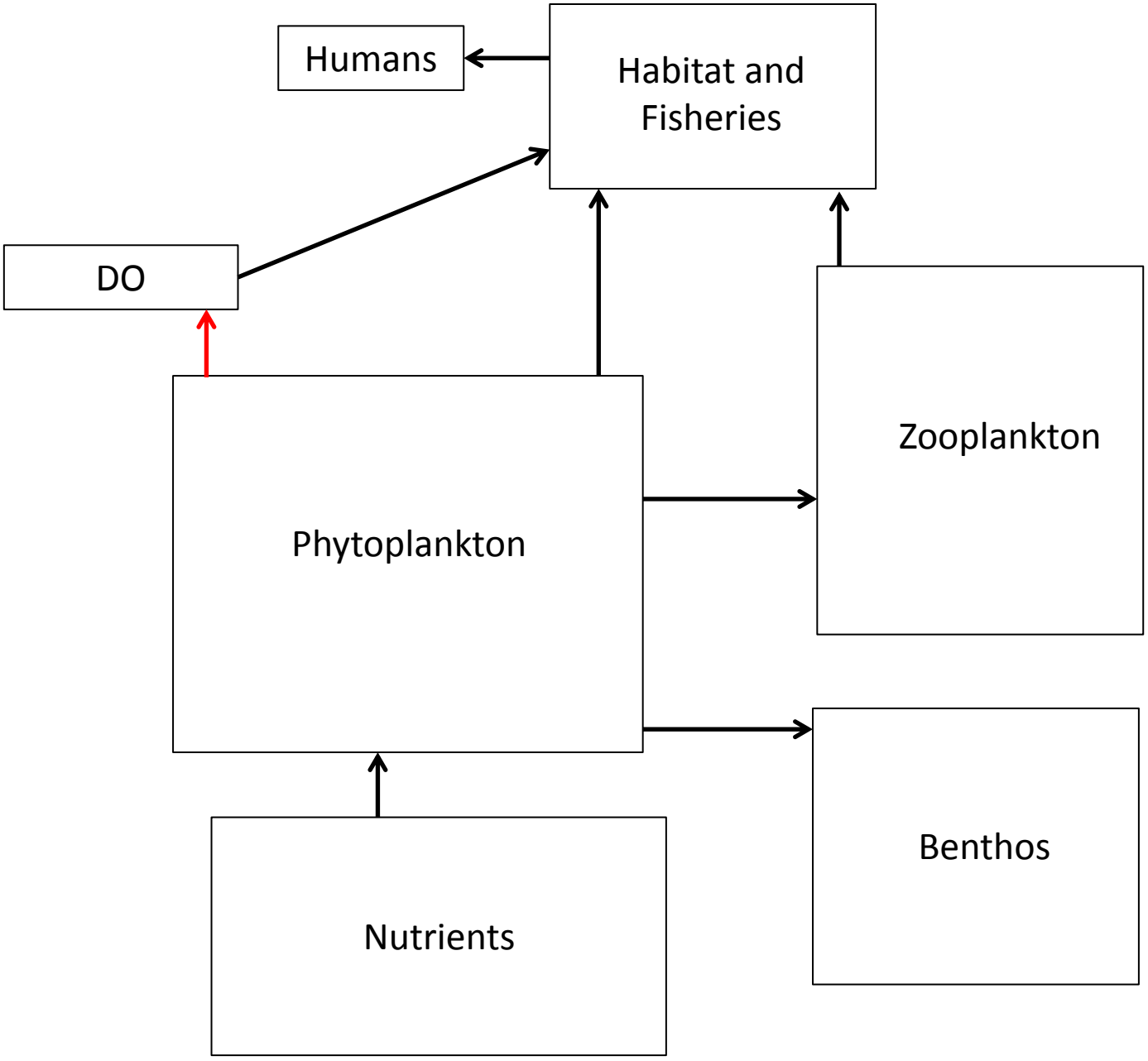
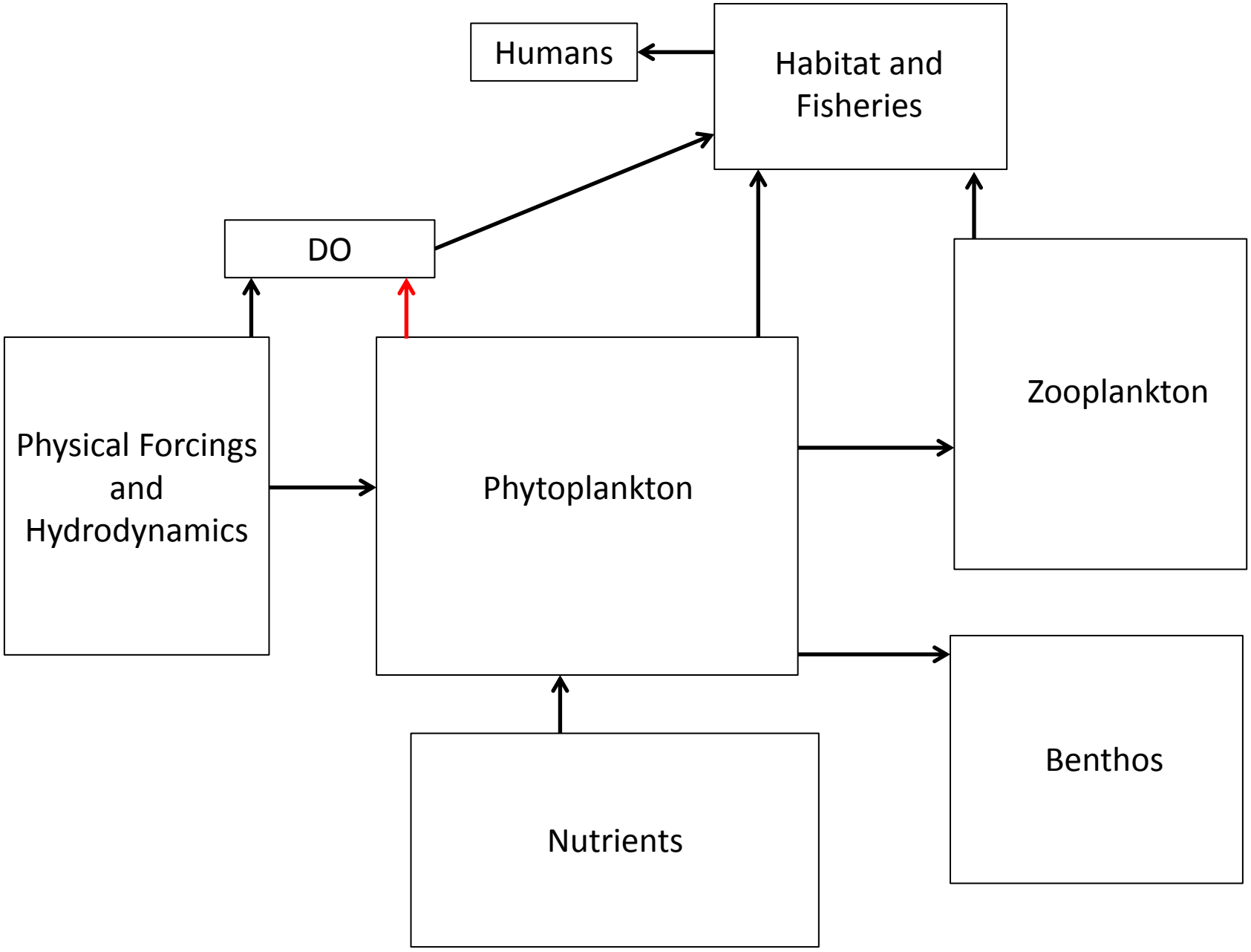

Humans
Habitat and Fisheries
DO
Zooplankton
Phytoplankton
Benthos
Nutrients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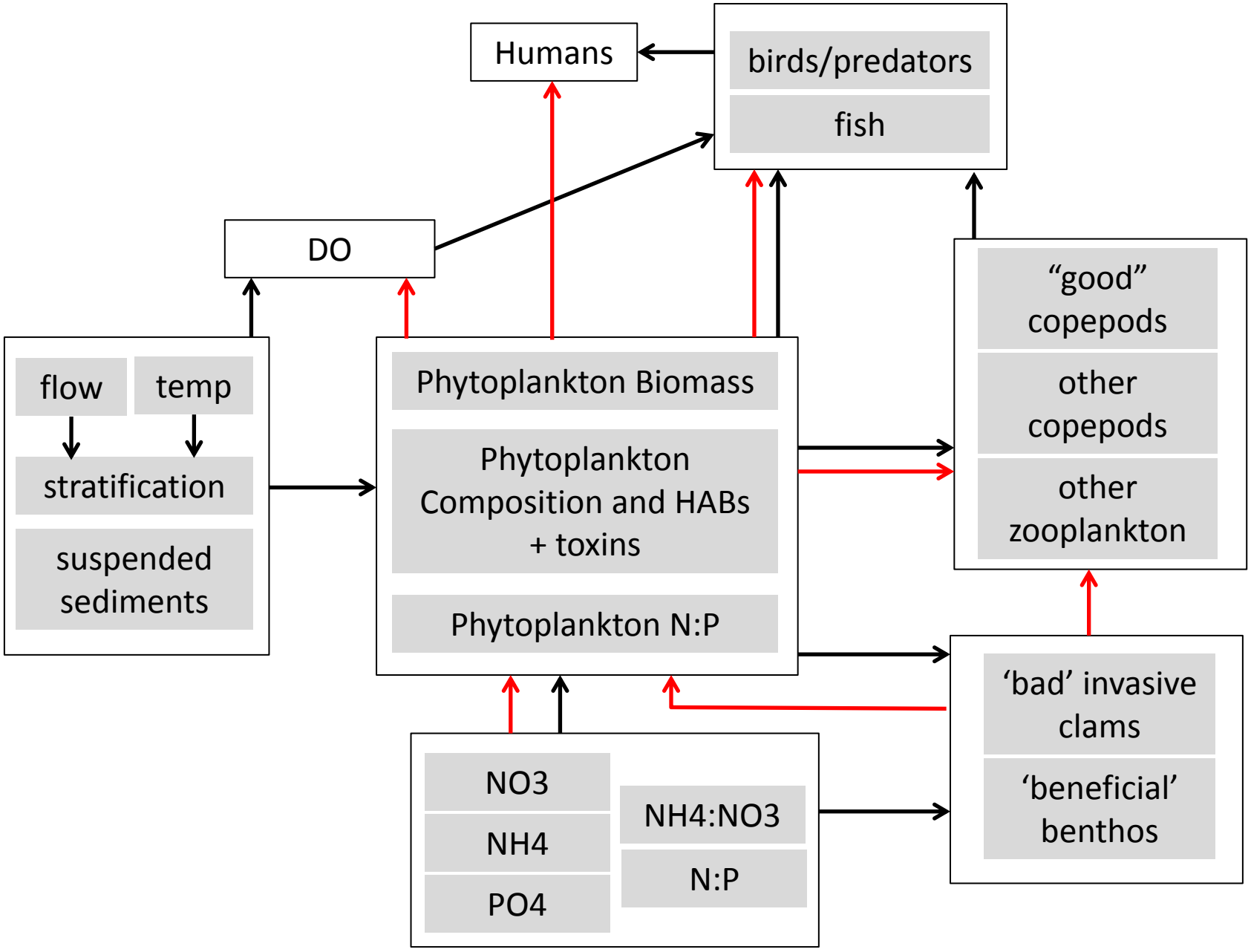
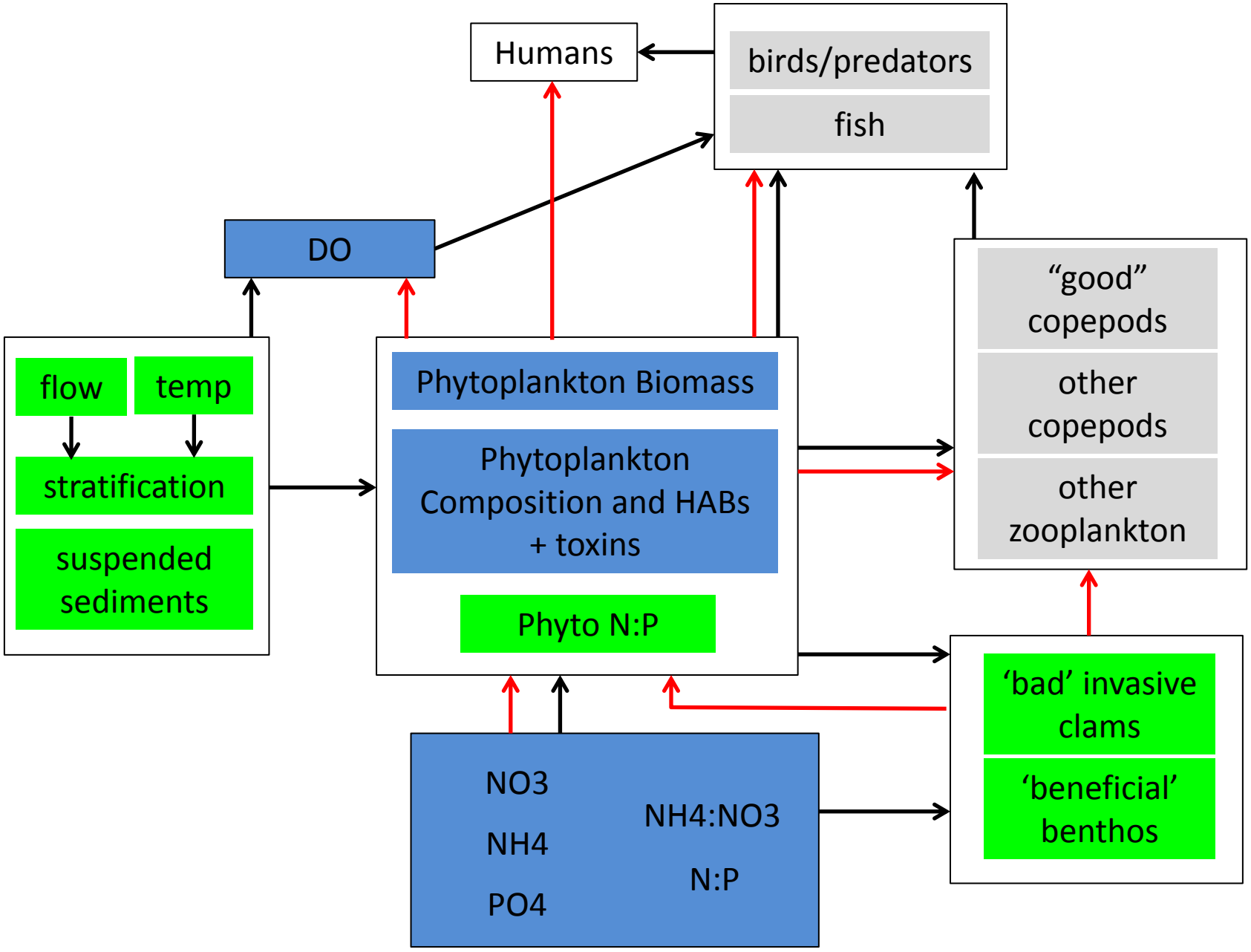

Humans
birds/predators
fish
DO
flow
temp
stratification
suspended sediments
Phytoplankton Biomass
Phytoplankton Composition and HABs + toxins
Phytoplankton N:P
"good" copepods
other copepods
other zooplankton
'bad' invasive clams
'beneficial' benthos
NO3
NH4
PO4
NH4:NO3
N:P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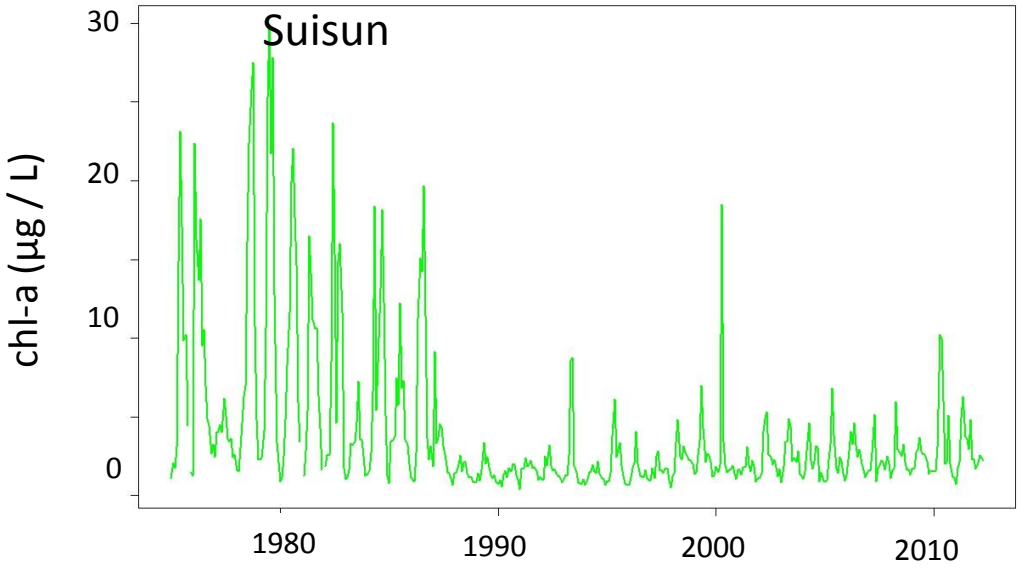
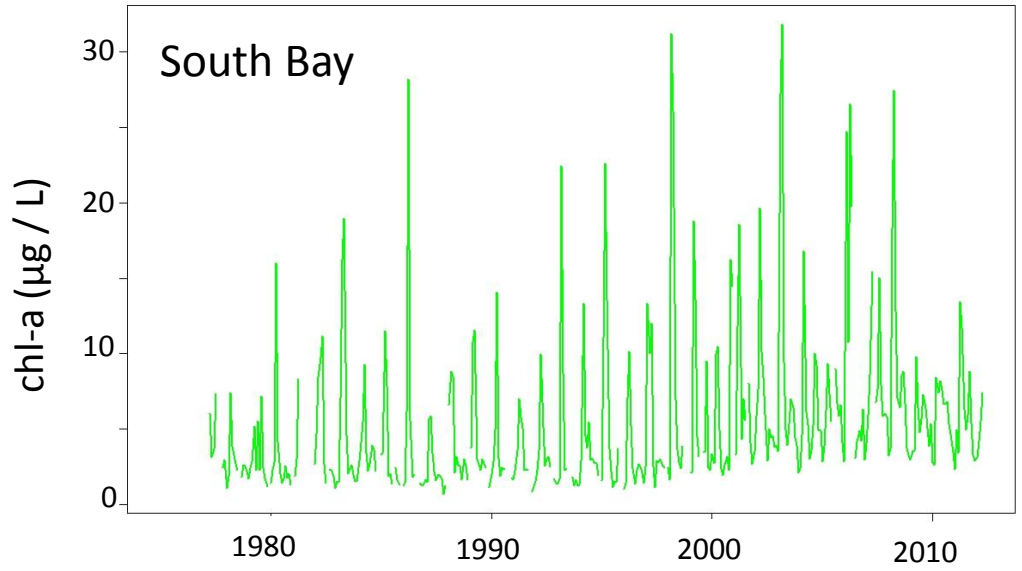


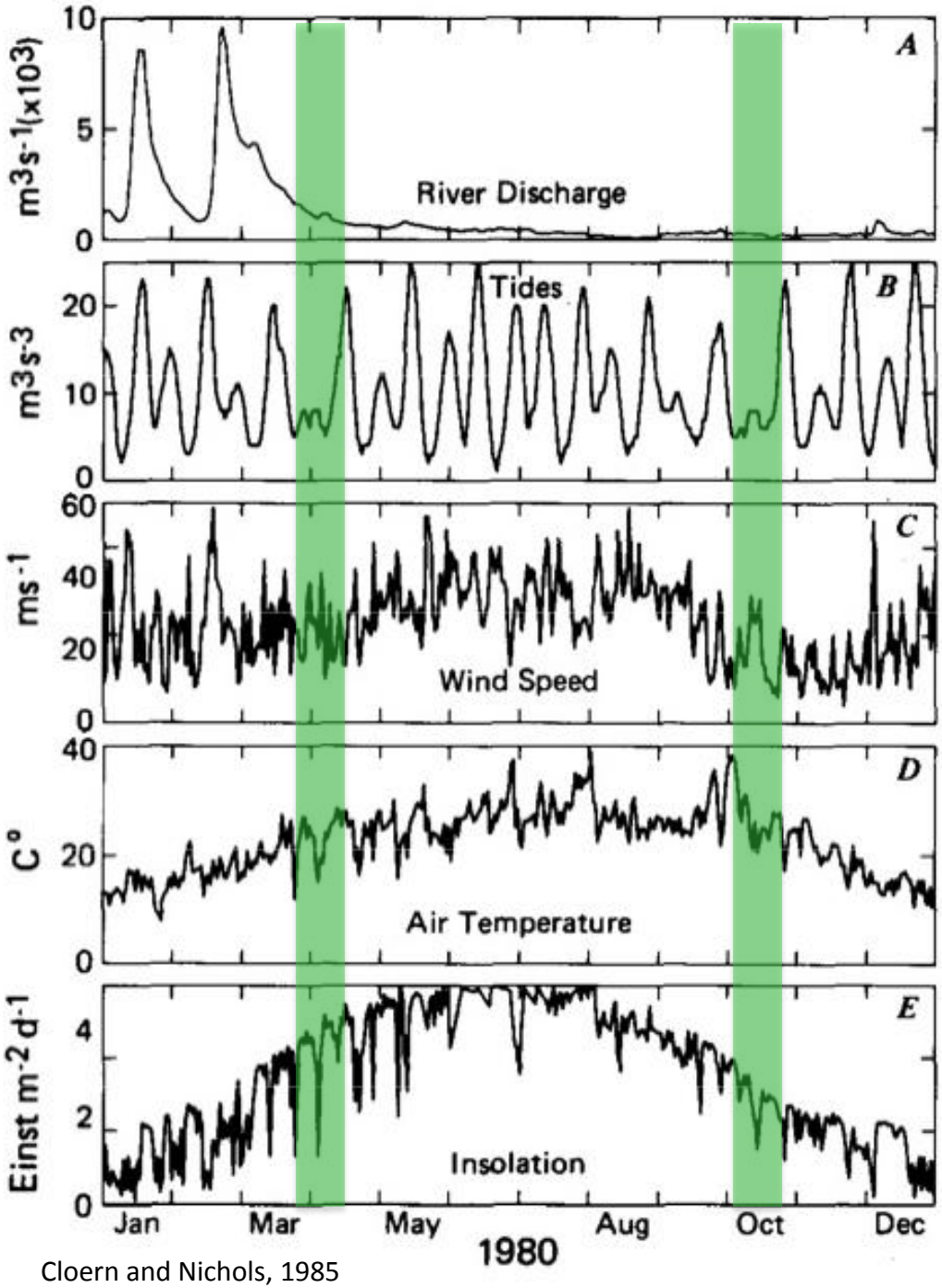


Needs to explain

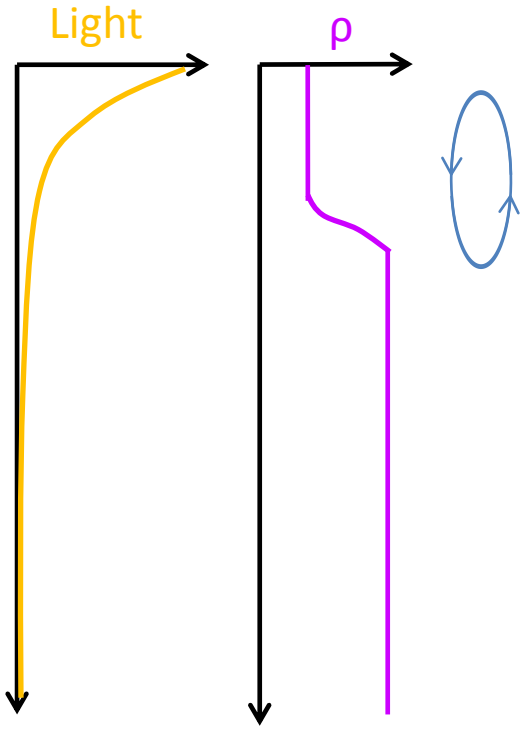
- interannual variability
- Long term trends
- Step-function changes

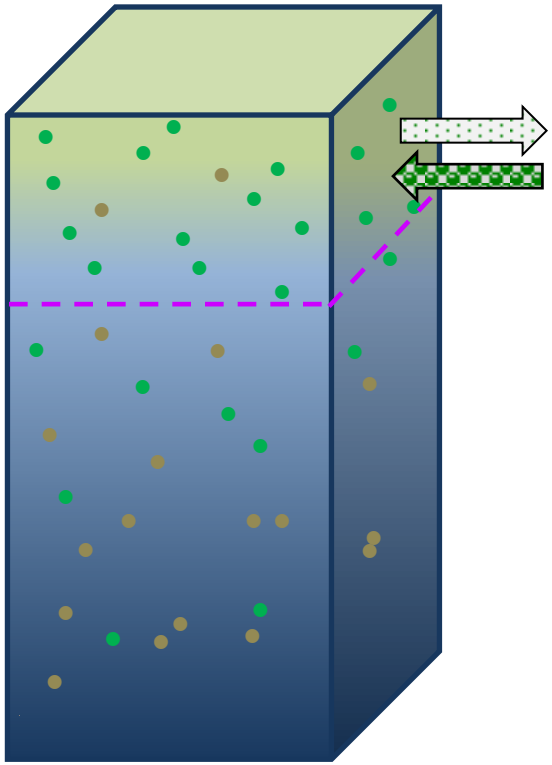
Data source: http://sfbay.wr.usgs.gov/access/wqdata/

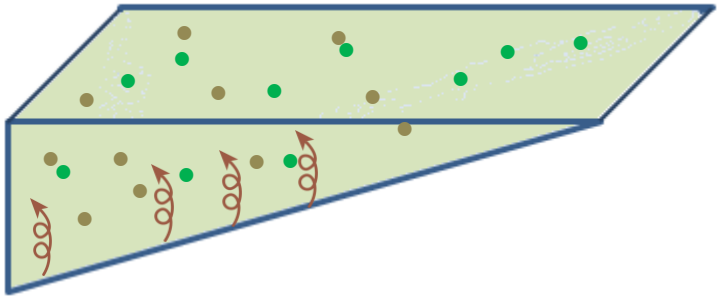
Phytoplankton Biomass CM

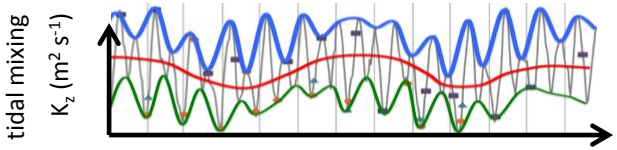


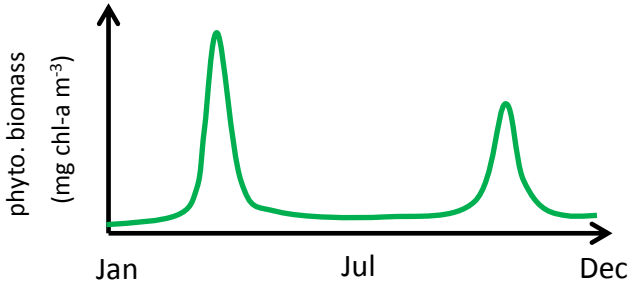
Cloern and Nichols, 1985

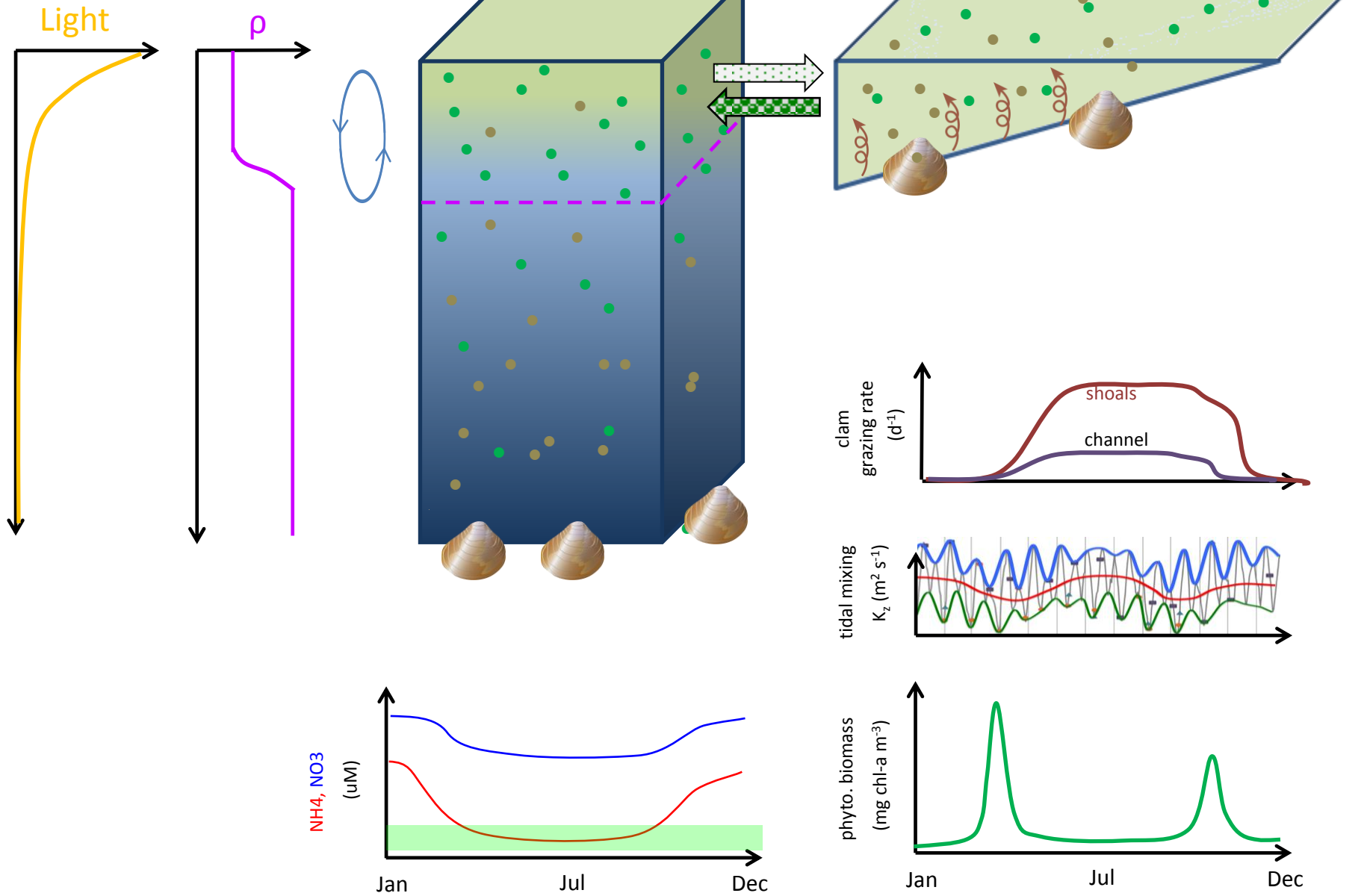

Light
ρ






tidal mixing
K_z (m^2 s^{-1})


phyto. biomass
(mg chl-a m^{-3})
Jan
Jul
Dec


Light
ρ
shoals
channel
clam grazing rate (d-1)
tidal mixing Kz (m2 s-1)
NH4, NO3 (uM)
Jan
Jul
Dec
phyto. biomass (mg chl-a m-3)
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Approach

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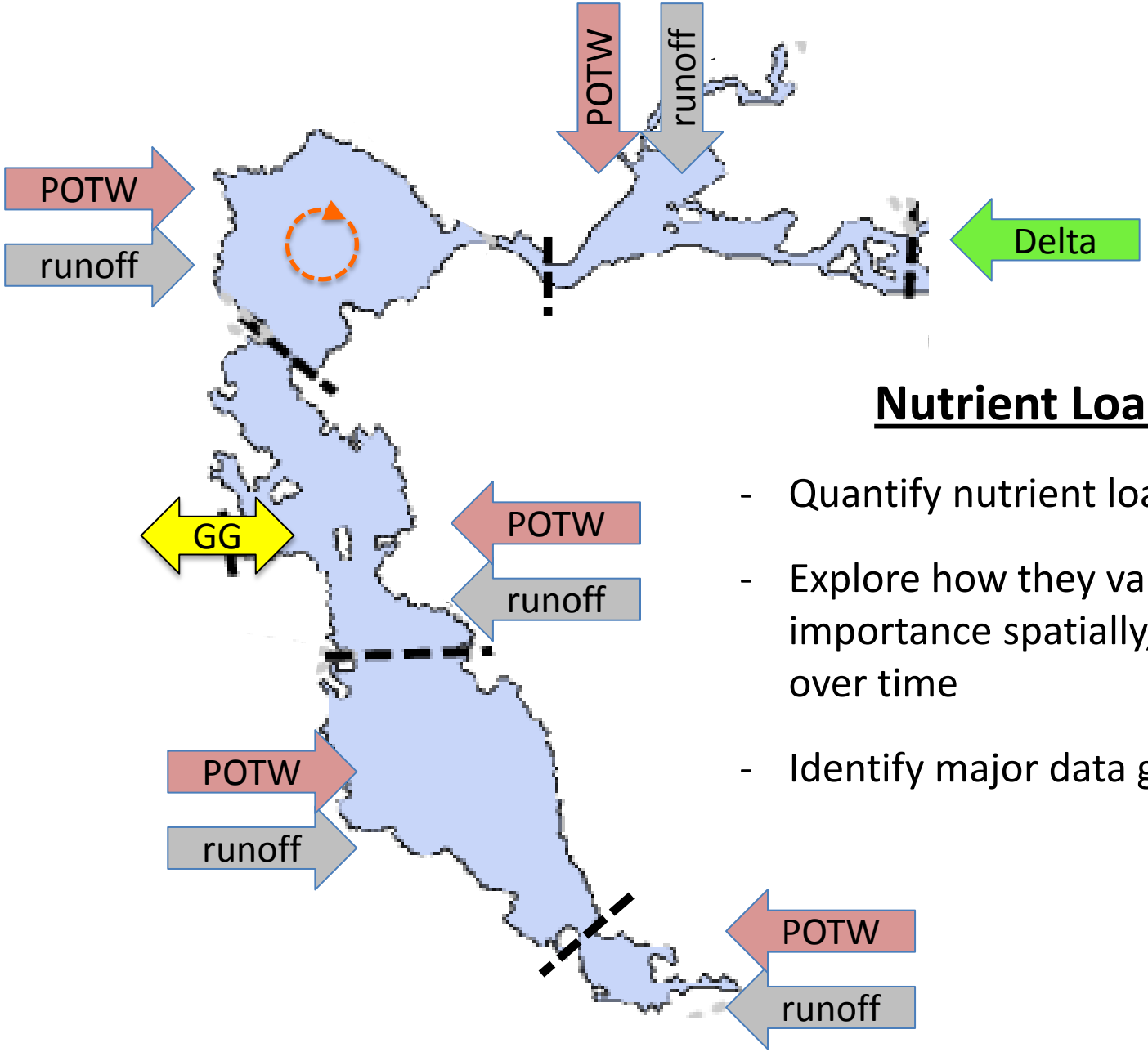
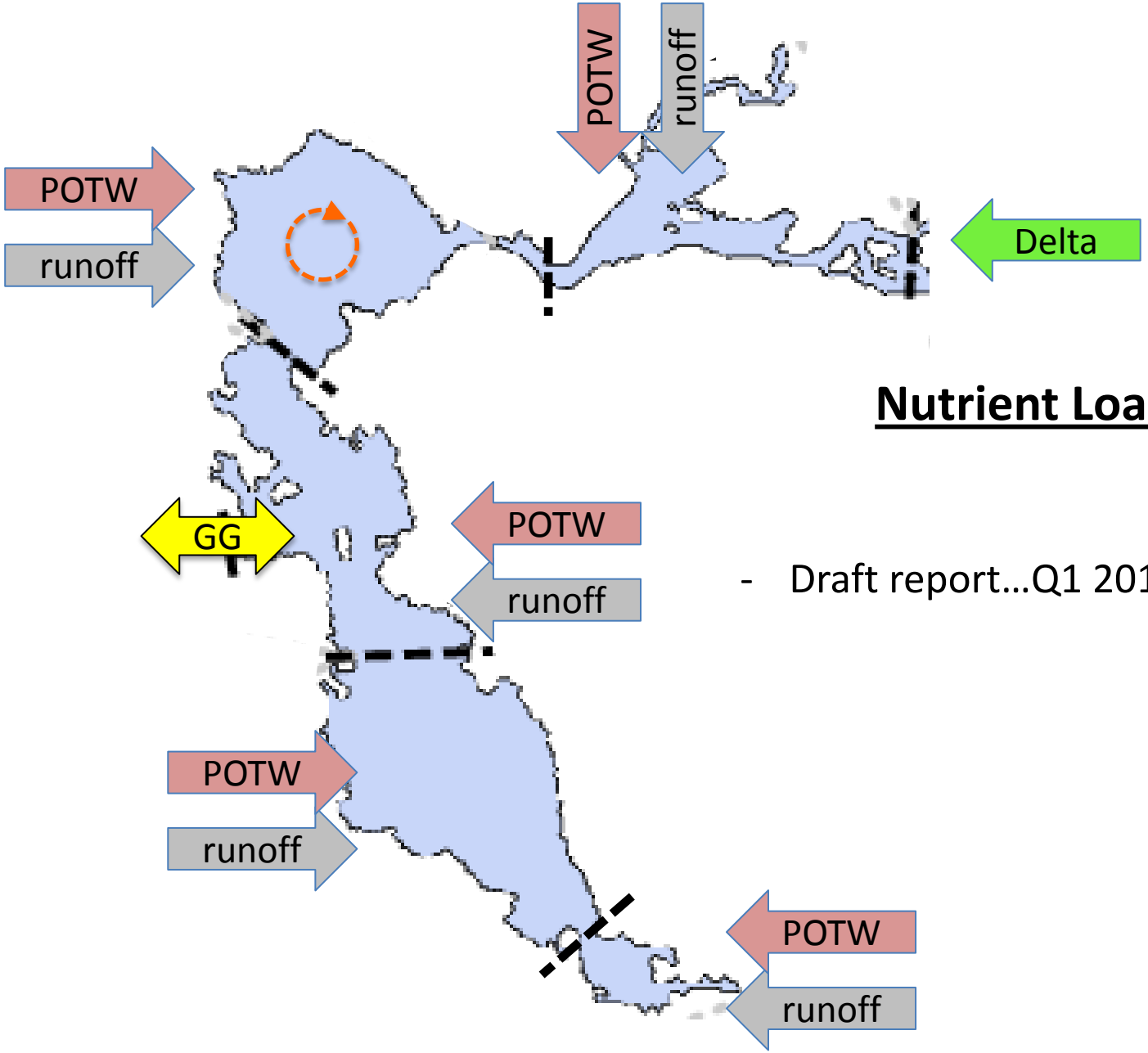


Nutrient Loading Study

- Quantify nutrient loads to SFB
- Explore how they vary in their relative importance spatially, seasonally, and over time
- Identify major data gaps



Nutrient Loading Study

- Draft report…Q1 2013


Source: C. Benton

Nutrient Program Update

Updates

- Conceptual Model
- Loading Study
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- Other priorities

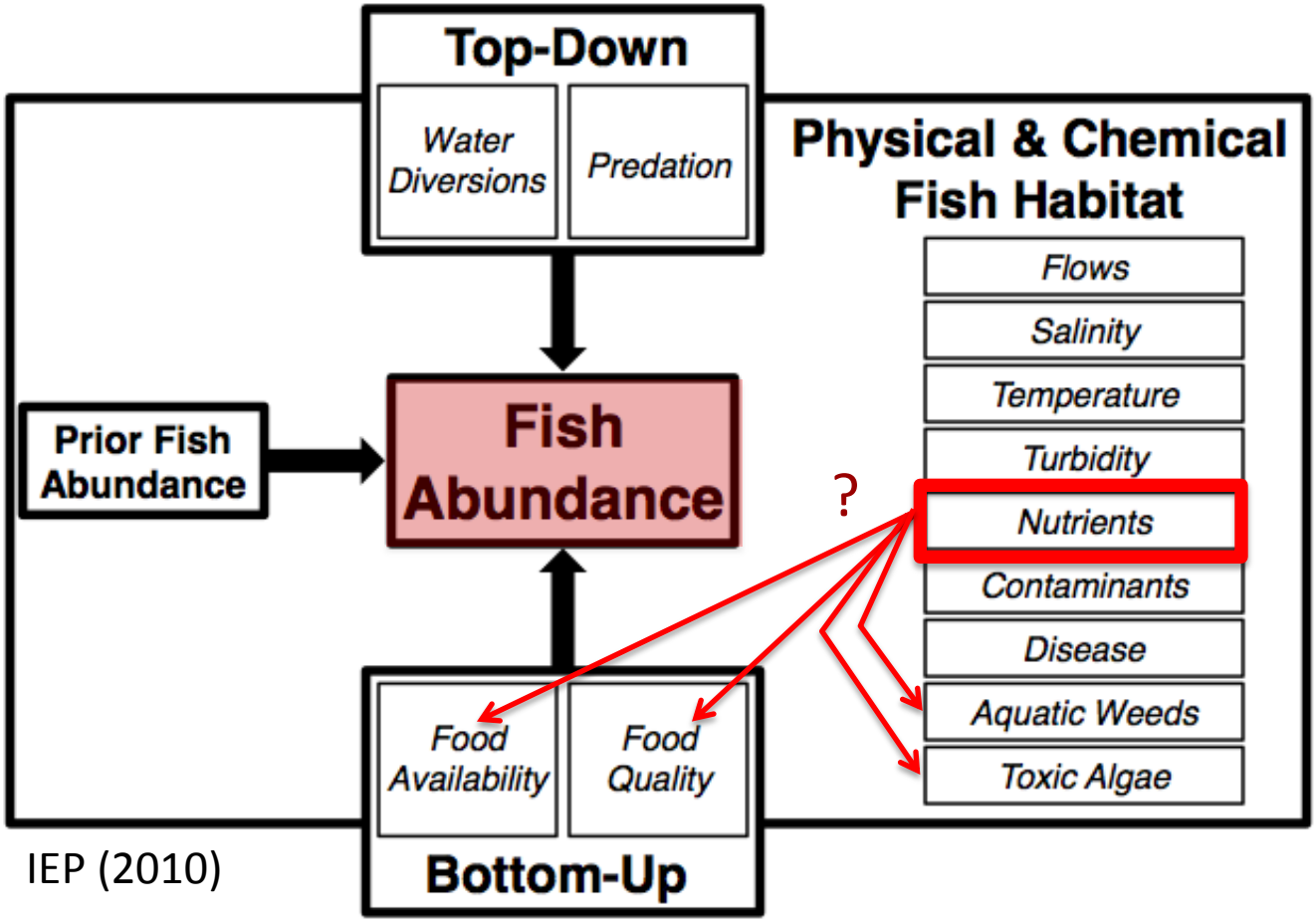
Suisun Bay: evaluating potential impacts of nutrients and NH_4^+

Complex management questions

- Pelagic Organism Decline (POD)
- Phytoplankton and zooplankton
  - Decreased abundance
  - Changes in community composition
- Potential links to nutrients, with specific focus on NH_4^+ ?

Dugdale et al., 2007; Parker et al. 2012a,b; Dugdale et al 2012
Glibert et al. 2011

Suisun Bay: evaluating potential impacts of nutrients and NH_4^+



IEP (2010)

Suisun Bay: evaluating potential impacts of nutrients and NH_4^+

Synthesis I:

- NH4 and primary production
- NH4 and copepods
- Ambient NH4 – sources, fate

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Workshop
Primary production → Recommendations

Peer Review
Copepods → Recommendations

Suisun Bay: evaluating potential impacts of nutrients and NH_4^+

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→ Workshop: Primary production → Recommendations

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Synthesis II

- N:P, NH4:NO3 on phytoplankton community composition
- 'Ecological stoichiometry'

→ Workshop → Recommendations

Synthesis III

- Overview: multiple stressors

→ Workshop → Recommendations

Suisun Synthesis I.

1. Synthesize the scientific literature on N utilization by marine and estuarine phytoplankton

2. NH4 inhibition of primary production: evaluate/synthesize results and interpretations of recent studies

   …through perspective of the broader scientific literature…

3. Synthesize scientific literature on copepod ecology and changes in community composition and abundance in Suisun

4. NH4 loads and concentrations: seasonal and long-term trends, and NH4 fate

5. Identify next steps.

Suisun Bay: evaluating potential impacts of nutrients and NH_4^+

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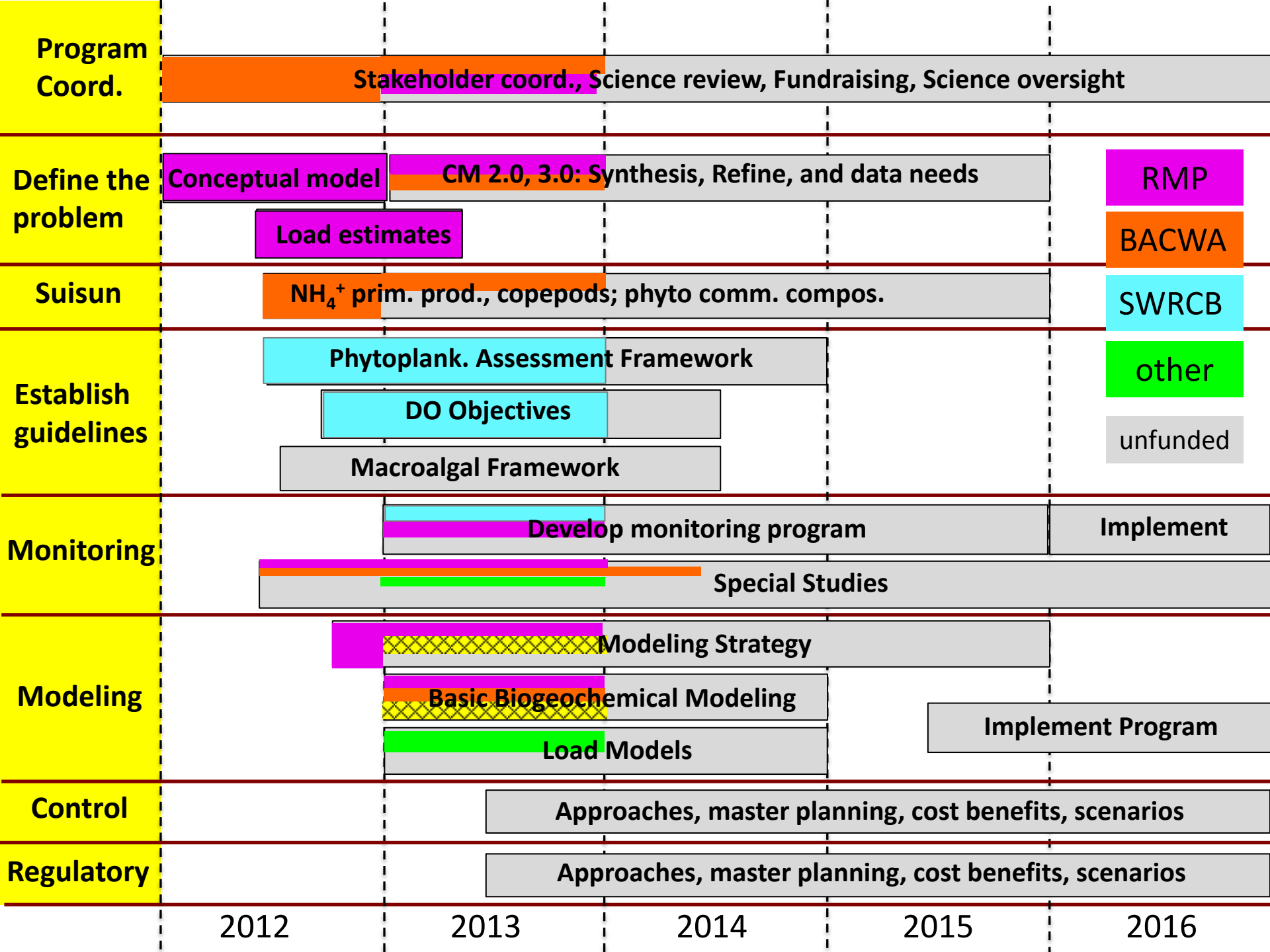
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RMP
BACWA
SWRCB
other
unfunded
2012
2013
2014
2015
2016

Priorities in 2013

- Assessment Framework
- Monitoring program development
- Load quantification/characterization
- Synthesis of existing data
- Special studies: Suisun Bay, elsewhere (?)
- Biogeochemical modeling: controls of phytoplankton biomass/composition, nutrient cycling

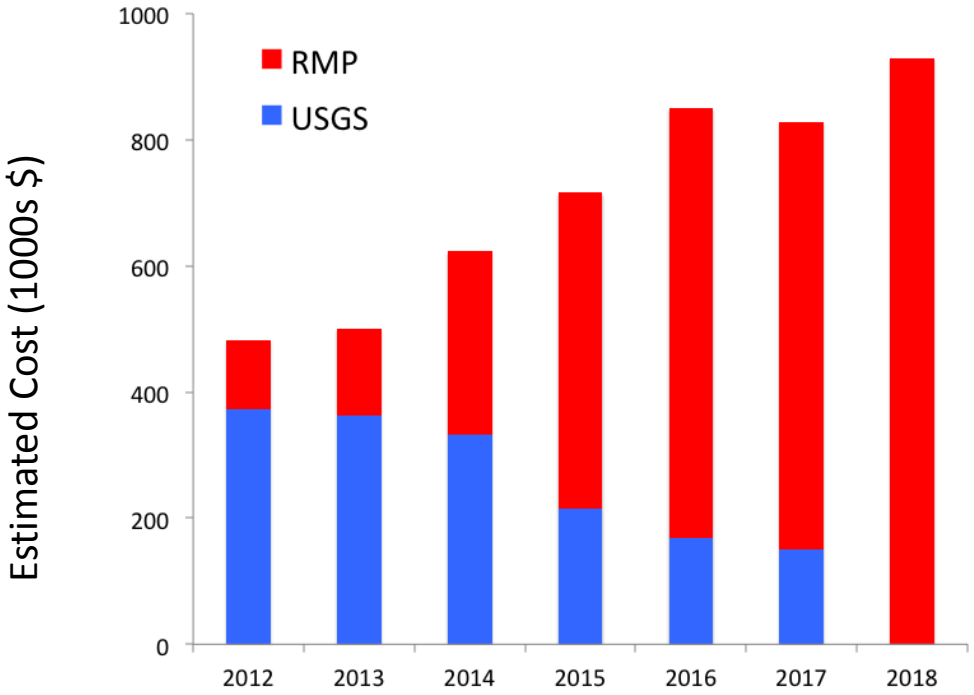
Priorities in 2013

- Assessment Framework
  - Phytoplankton and DO assessment framework

SWRCB

Priorities in 2013

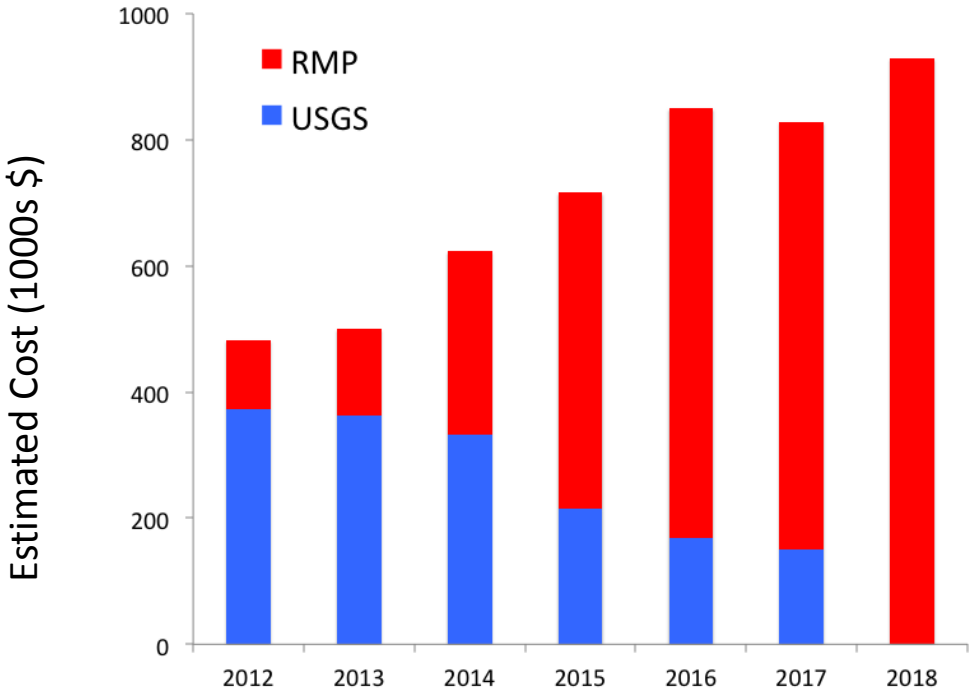
- Monitoring Program and Special Studies development:



J Cloern, pers. comm.

Priorities in 2013

- Monitoring Program and Special Studies development:
  - Planning: transition, institutions, costs, funding — SWRCB
  - Moored sensor pilot study — RMP, USGS
  - Develop algal toxin measurement approaches — RMP



J Cloern, pers. comm.

Major Questions Related to Monitoring Program

Scientific

- Parameters to be measured, most efficient approaches?

- What spatial/temporal frequency?
    - shallows

- What combination of approaches is needed
    - ship-based, moored sensors, others

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Institutional

- Approx. cost for running the program?

- What institutional agreements need to be established?
    - e.g., continued partnering with USGS, IEP

- Transition timeline?

Monitoring Program Development I

PI: D Senn, J Cloern (USGS)

Objective: Develop a transition plan for Monitoring Program migration from USGS to RMP

Approach:

- Convene advisory team: regional scientists, stakeholders, regulators
- Historic data and future measurements – what/where/when/how
- Investigate costs, infrastructure, logistics for various scenarios
- Identify institutional agreements, timelines, constraints

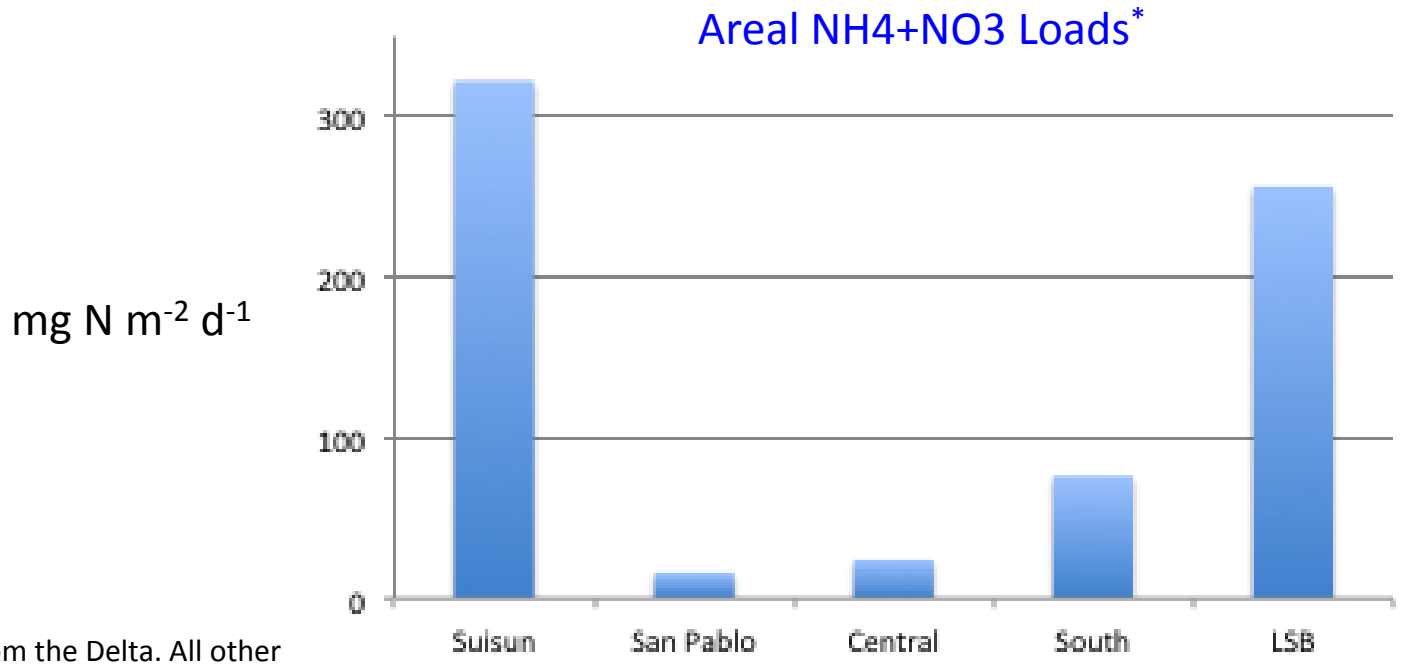
-*Product:* Technical Report on migration plan

Priorities in 2013

- Load quantification
  - Load estimates continuation — RMP
  - Stormwater loads — RMP
  - Loads to Suisun Bay from Delta — IEP
  - Effluent characterization — BACWA

Priorities in 2013

- Synthesis
  - Lower South Bay Synthesis — BACWA
  - Suisun synthesis II — BACWA



*Suisun includes loads from the Delta. All other loads do not consider upstream; only

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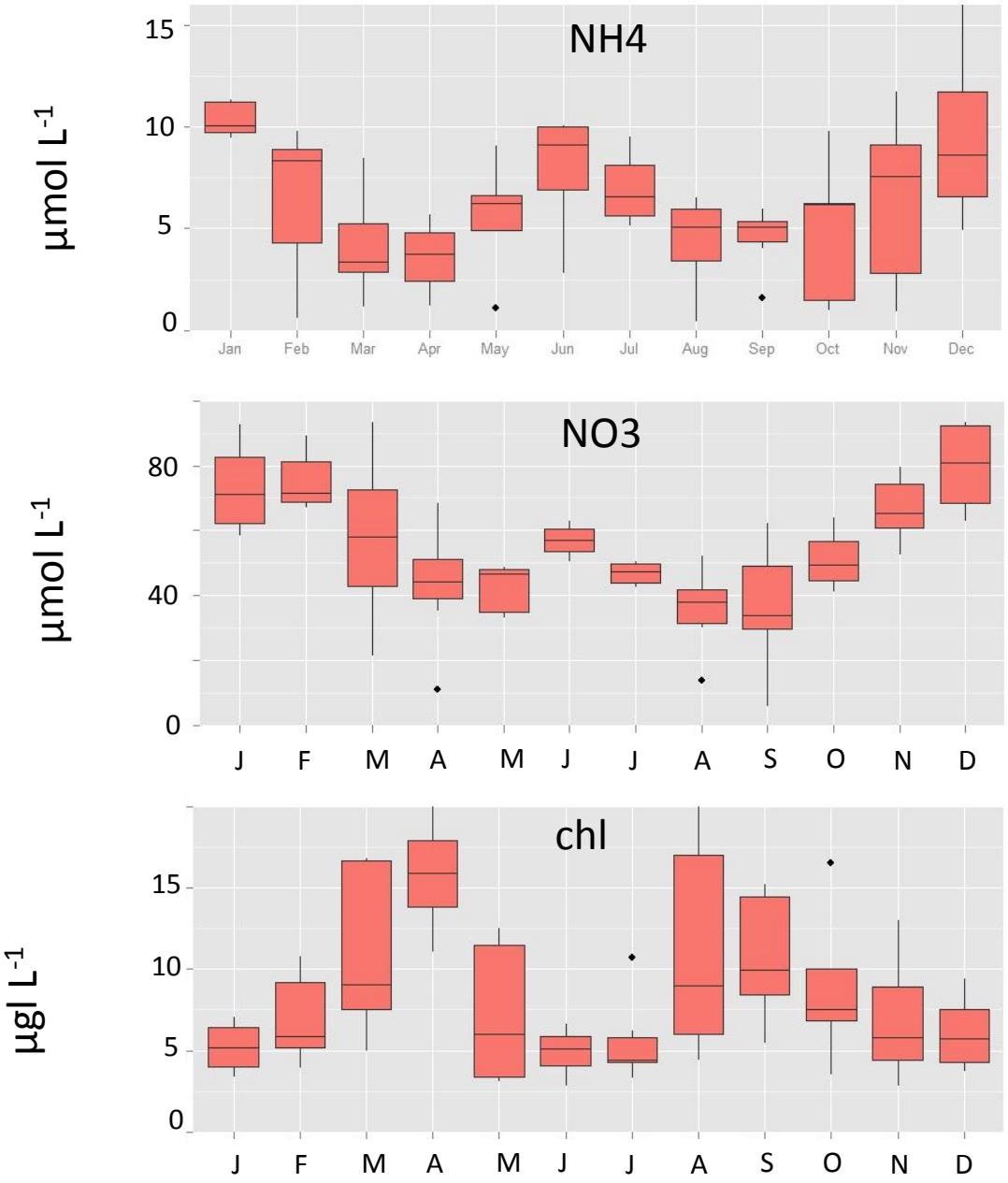
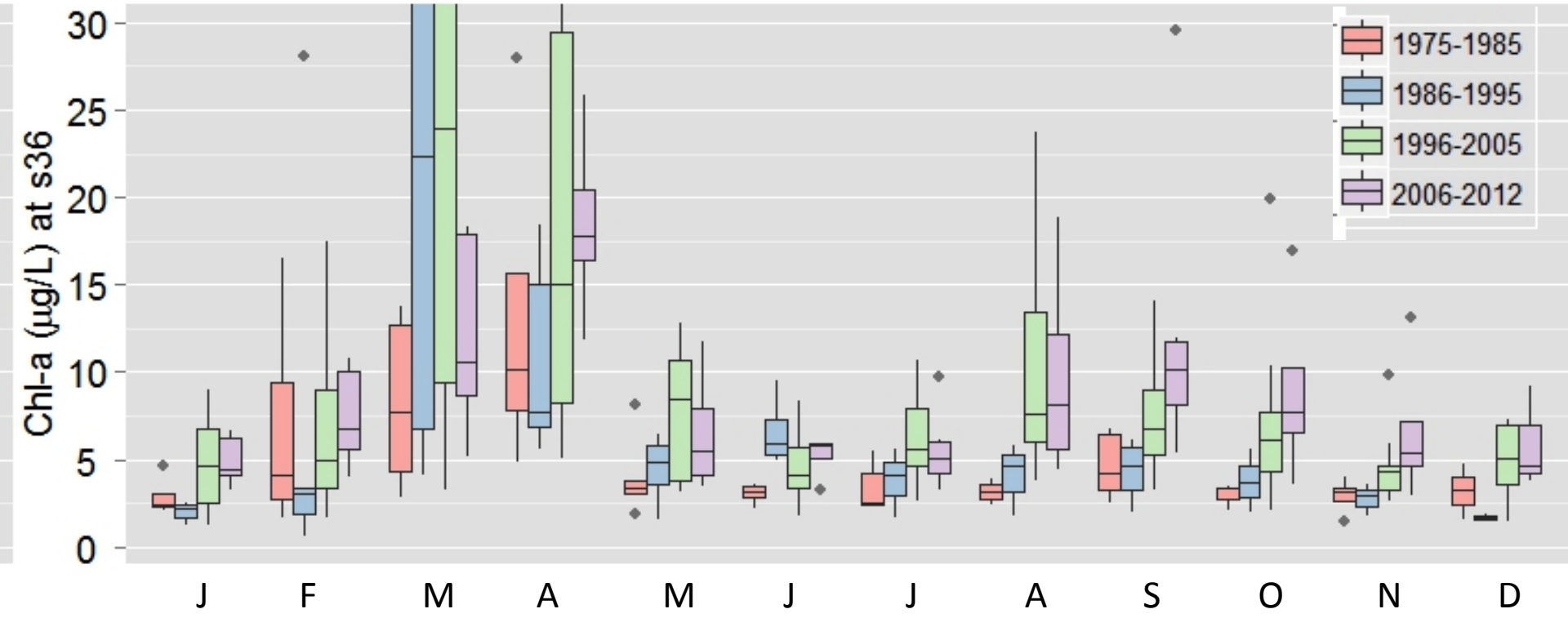
Lower South Bay

NH4, NO3, and chl-a
2006-2011



Data source: http://sfbay.wr.usgs.gov/access/wqdata/

Lower South Bay



Synthesis (and modeling)

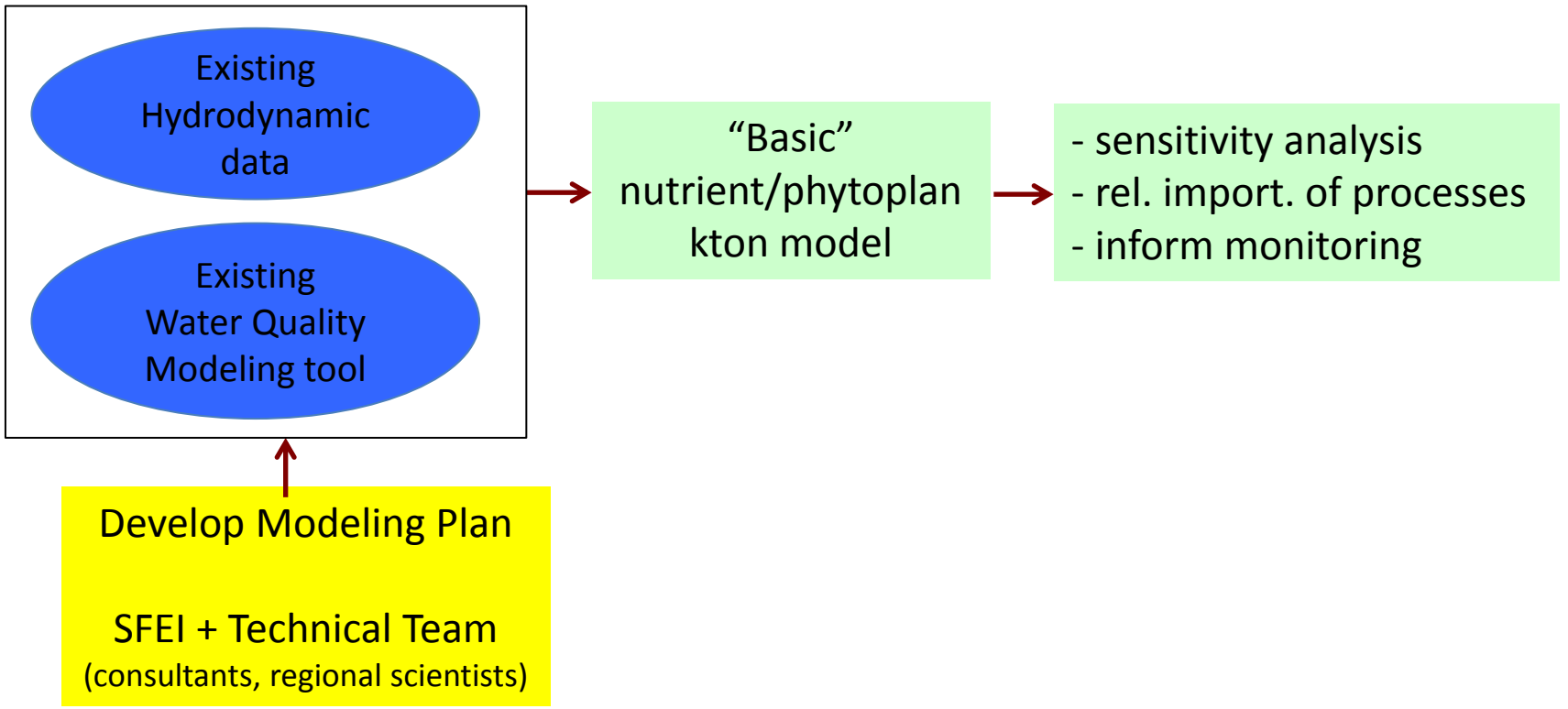
- Phytoplankton biomass
- Species composition
- Temporal and seasonal variability in benthic filter feeders
- Dissolved O2 (including sensor data)
- Exchange with salt ponds

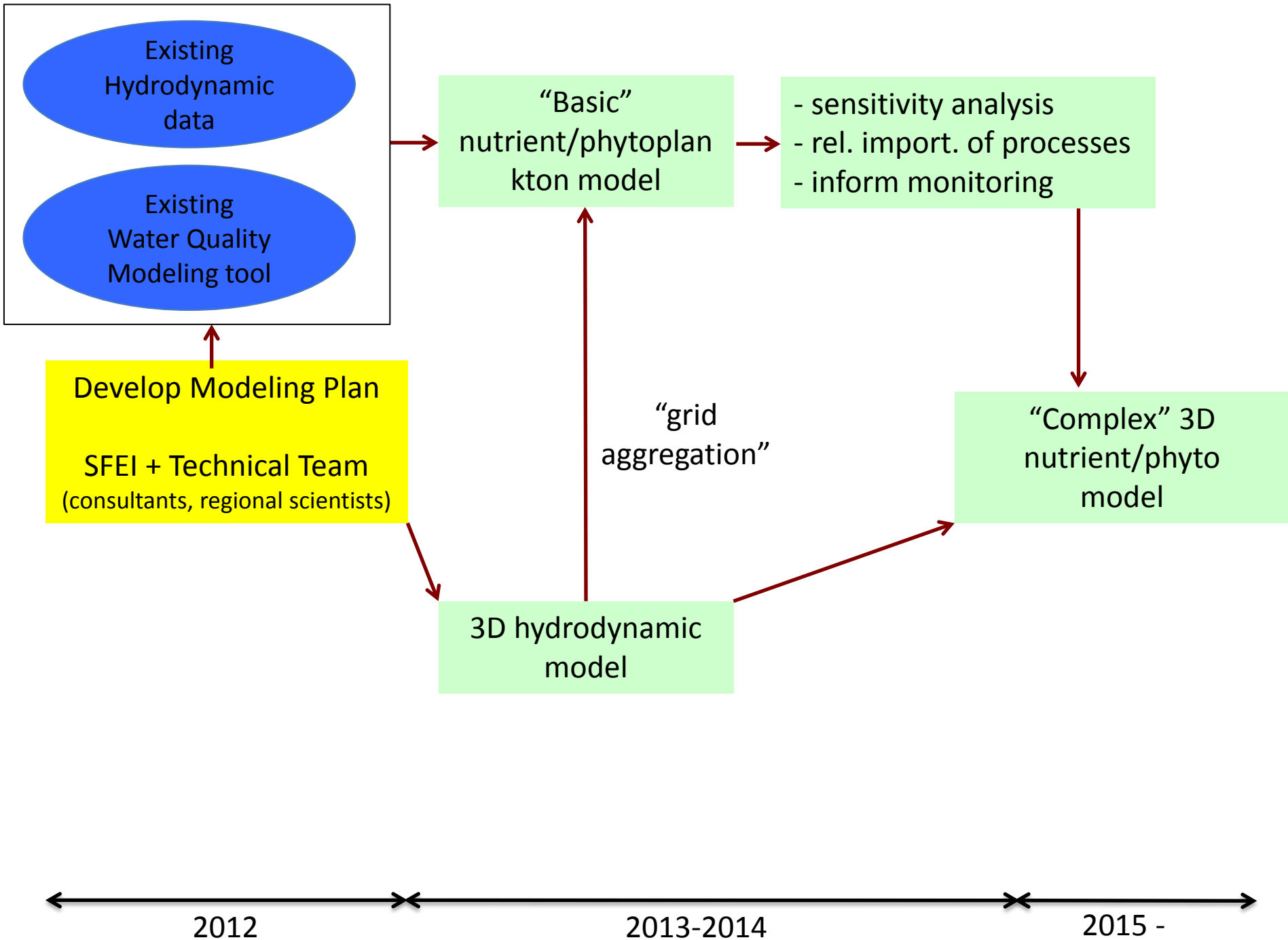
Priorities in 2013

- Synthesis
  - Lower South Bay Synthesis — BACWA
  - Suisun synthesis II — BACWA
  - Biogeochemical modeling
    - Quantitative synthesis – load/response/fate
    - Relative importance of major processes
    - Data and conceptual gaps

Modeling Related Questions

- What are the relative importance of factors controlling primary production and biomass accumulation?
  - light limitation, clam grazing, NH4-inhibition
- What is the Bay's natural ability to assimilate/process nutrient loads?
  - transformations, losses, flushing
- Under what future conditions might impairment be expected? e.g.,
  - Causes:
    - prolonged stratification, loss of clams, water clarity
  - Effect:
    - Low dissolved O_2, acute blooms, HABs, shifts in species composition
- What effect might various control measures have on mitigating problem?


Existing Hydrodynamic data
Existing Water Quality Modeling tool
"Basic" nutrient/phytoplankton model
- sensitivity analysis
- rel. import. of processes
- inform monitoring
Develop Modeling Plan
SFEI + Technical Team
(consultants, regional scientists)
2012
2013-2014
2015 -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- rel. import. of processes
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Develop Modeling Plan
SFEI + Technical Team
(consultants, regional scientists)
"grid aggregation"
"Complex" 3D nutrient/phyto model
3D hydrodynamic model
2012
2013-2014
2015 -

On-going and 2013 Suisun Bay Studies

- NH4 toxicity to copepods
  - SFCWA, Central San, Regional Board
- Inhibition of primary production in Suisun Bay
  - SFCWA, Central San, Regional Board
- Effects of nutrient forms, nutrient ratios and light availability on lower food webs of the Bay Delta (Glibert, Wilkerson, Dugdale, Parker; DSC)
- Factors influencing *Microcystis* blooms (Parker et al.; DSC)

On-going and 2013 Suisun Bay Studies

- Physiological Assessment of the "Bad Suisun" Phenomenon: Light and Nutrient Interactions (Kudela, Berg, Taberski; IEP)

- Environmental controls of sediment-water nitrogen and phosphorus exchange across the Delta-Suisun salinity gradient (Cornwell and Glibert; SFCWA)

- Effects of changing phytoplankton stoichiometry on copepods (Pierson and Glibert; IEP)

- Nutrient loads, transformations, and losses in the Delta (SFEI, USGS, RMA; IEP)